What is claimed is:

1. An electrode for a plasma arc torch, the electrode comprising:

an elongated electrode body formed of a high thermal conductivity material and having a bore disposed in a bottom end of the electrode body; and

a ring-shaped insert comprising a high thermionic emissivity material disposed in the bore.

2. The electrode of claim 1 wherein the bore is ring-shaped.

3. The electrode of claim 1 wherein the high thermionic emissivity material is hafnium or zirconium.

4. The electrode of claim 1 wherein the insert further comprises a closed end which defines an exposed emission surface.

5. The electrode of claim 1 wherein the insert comprises a first ring-shaped member formed of a high thermionic emissivity material and a second cylindrical member formed of a high thermal conductivity material disposed in the first ring-shaped member.

6. The electrode of claim 1 wherein the insert comprises a first ring-shaped member comprising of a high thermionic emissivity material disposed in a second ring-shaped member formed of a high thermal conductivity material.

7. The electrode of claim 1, 4 or 5 wherein the second insert comprises copper, silver, gold, or platinum.

8. The electrode of claim 1 wherein the insert comprises a rolled pair of adjacent layers, the first layer comprising the high thermal conductivity material and a second layer comprising the high thermionic emissivity material.

9. The electrode of claim 1 wherein the insert further comprises a high thermal conductivity material.

10. An electrode for a plasma arc torch, the electrode comprising:

an elongated electrode body formed of a high thermal conductivity material and having a bore disposed in a bottom end of the electrode body; and

an insert disposed in the bore and comprising a high thermal conductivity material and a high thermionic emissivity material.

11. The electrode of claim 10 wherein the high thermionic emissivity material is hafnium or zirconium.

12. The electrode of claim 10 wherein the a high thermal conductivity material comprises copper, silver, gold, or platinum.

13. The electrode of claim 10 wherein the insert comprises a rolled pair of adjacent layers, the first layer comprising the high thermal conductivity material and a second layer comprising the high thermionic emissivity material.

14. The electrode of claim 13 wherein the first layer comprises hafnium plating and the second layer comprises a copper foil.

15. The electrode of claim 10 wherein the electrode body has a ring-shaped bore and the insert is ring-shaped.

16. The electrode of claim 15 wherein the insert further comprises a closed end which defines an exposed emission surface.

17. The electrode of claim 10 wherein the insert comprises:

a cylindrical high thermal conductivity material having a plurality of parallel bores disposed in a spaced arrangement; and

a plurality of elements comprising the high thermionic emissivity material, each member being disposed in one of the plurality of bores.

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18. A method of manufacturing an electrode for a plasma arc torch comprising:

a) providing an elongated electrode body formed of a high thermal conductivity material;

b) forming a bore at a bottom end of the elongated electrode body relative to a central axis through the electrode body; and

c) inserting a ring-shaped insert comprising a high thermionic emissivity material in the bore.

19. The method of claim 18 wherein step b) comprises:

b1) forming a ring-shaped bore.

20. The method of claim 19 wherein step c) comprises:

c1) inserting in the bore an insert having one closed end which defines an exposed emission surface.

21. The method of claim 18 wherein step b) comprises:

b1) forming a cylindrical bore.



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22. The method of claim 21 wherein step b) comprises:

b1) forming the insert from a first ring-shaped member comprising a high thermionic emissivity material and a second cylindrical member comprising a high thermal conductivity material disposed in the ring-shaped first insert.

23. The method of claim 22 wherein step b) comprises:

b1) forming a cylindrical bore having an inner bore and a deeper outer bore, such that the first member fits in the outer bore and the second member fits in the inner bore.

24. The method of claim 22 wherein step b) comprises:

b1) forming a cylindrical bore having an outer bore and a deeper inner bore, such that the first member fits in the outer bore and the second member fits in the inner bore.

25. The method of claim 18 wherein step c) further comprises:

c1) forming the insert from a composite powder mixture of a high thermal conductivity material and a high thermionic emissivity material.

26. The method of claim 25 wherein the composite powder mixture comprises grains of the thermal conductivity material coated with the high thermal conductivity material.

27. The method of claim 18 wherein step c) further comprises forming the insert by:

c1) forming a plurality of parallel bores disposed in a spaced arrangement within a cylindrical high thermal conductivity material; and

c2) positioning each of a plurality of elements comprising the high thermionic emissivity material in a respective one of the plurality of bores.

28. The method of claim 18 wherein step c) further comprises forming the insert by:

c1) placing a first layer comprising the high thermal conductivity material adjacent a second layer comprising the high thermionic emissivity material; and

c2) rolling the adjacent layers.

29. A method of manufacturing an electrode for a plasma arc cutting torch, comprising:

a) providing an elongated electrode body formed of a high thermal conductivity material;

b) forming a bore at a bottom end of the elongated electrode body relative to a central axis extending longitudinally through the electrode body;

c) forming an insert comprising a high thermal conductivity material and a high thermionic emissivity material; and

d) inserting in the bore of the electrode body.

30. The method of claim 29 wherein step c) comprises:

c1) providing a first layer of high thermal conductivity material and disposed adjacent a second layer of high thermionic emissivity material; and

c2) rolling the adjacent layers.

31. The method of claim 29 wherein step c) comprises the steps of:

c1) forming a composite powder comprising the high thermal conductivity material and the high thermionic emissivity material; and

c2) sintering the powder to form the insert.

32. The method of claim 31 wherein step c1) comprises:

c11) coating grains of high thermionic emissivity material with the high thermal conductivity material.

33. The method of claim 28 wherein step c) comprises:

c1) forming a plurality of parallel bores disposed in a spaced arrangement within the high thermal conductivity material; and

c2) positioning each of a plurality of elements comprising the high thermionic emissivity material in a respective one of the plurality of bores.

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